Thermal conductivity of ZrO2 based layers investigated by the 3ω method

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Aim of the project is to set up a diagnostic technique to measure the thermal conductivity of thin ZrO2 layers which are deposited via Plasma-enhanced chemical vapor deposition (PECVD) and can be used for galvanic and thermal isolation. The 3ω method was chosen as a surface-sensitive technique with high accuracy and short equilibration time.
This method can be applied to bulk amorphous solids and crystals as well as to amorphous films tens of microns thick. A thin electrically conductive wire is deposited onto the specimen to measure its thermal conductivity. The wire serves both, as a heater and as a temperature sensor. Joule heating at 2ω frequency occurs when an ac current with angular modulation frequency ω is applied to the wire. The generated thermal wave diffuses into the specimen. This causes a modulation of the resistance at 2ω due to the temperature dependence of the resistance. The voltage drop along the wire then contains a contribution from a third harmonic that depends on the modulated temperature rise of the heater and is used to calculate the samples thermal conductivity.
We will present the setup, its characterization by using reference samples, results on ZrO2 layers and the influence of the structure and morphology of these layers on the thermal conductivity. Furthermore, we will show how the thermal conductivity of amorphous and crystalline ZrO2 layers depend on the temperature.